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*Harvesting geoduck on an intertidal geoduck farm in Puget Sound, Washington*

# Geoduck Culture on Intertidal Beaches: Procedures, Expenses and Anticipated Income for an Intermediate-Size Farm

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## Introduction and Scope of Document

The purpose of this document is to describe the procedures and expenses anticipated by business entities or persons engaged in farming intertidal beaches for geoduck production. This document is separated into four sections. The first section describes issues relating specifically to site characterization for optimal geoduck farming. The second section describes the deployment of culture gear, procedures for planting geoduck seed and costs associated with materials and labor in establishing and maintaining a site. The third section is a summary of risk factors specifically associated with initiating geoduck culture in an untested site, from a shellfish farmer's perspective. The fourth section is an Excel spreadsheet detailing the expenses associated with establishing and maintaining an intertidal site utilized for the establishment of 20,000 geoduck tubes annually over a six-year production cycle. This document does not consider in any detail costs associated with the marketing or sale of geoducks, but does take into account anticipated revenues associated with the harvest of geoducks after the sixth year of grow out.



*Partial block of geoduck tubes at Thorndyke Bay (Baywater, Inc.)*

## I Site characterization Associated with Intertidal Geoduck Culture

Sites associated with successful geoduck farming include a suite of characteristics relating to water quality, sediment and substrate characteristics, tidal height relative to mean lower low water (MLLW), suspended food availability, exposure to prevailing storm waves and wind and availability of upland infrastructure associated with intertidal shellfish farming.

### *Water Quality Considerations*

Water quality is the primary consideration for siting a geoduck farm. All shellfish growing and harvesting activities are covered by WAC Chapter 246-282. Sites must be included in the Washington Department of Health's database of locations that are classified as Approved, or Conditionally Approved for growing and harvesting shellfish.

The operator must also have an aquatic farm license and a DOH approved commercial shellfish license. Sites that are not currently monitored by the DOH will require a period of annual monitoring in order to include in either the Approved or Conditionally Approved classification. Federal laws are also associated with the culture and harvest of shellfish and are included in the National Sanitation Program 1999 Model Ordinance. Information on these aspects of water quality can be addressed at the WA Dept. of Health website: <http://www.doh.wa.gov>

The second critical component associated with water quality relates to the prevalence, periodicity and extent of marine biotoxins in shellfish in the area of the proposed site. Geoducks are documented to uptake and retain PSP biotoxin at differential rates. Toxin retention may be prolonged in the visceral mass (gut ball) for weeks to months while siphon and mantle tissues are not affected. This is a critical factor for prospective growers to consider as harvesting geoduck will likely be curtailed if PSP closures have occurred at or nearby the site of interest. Because PSP levels vary between individual clams, closures for geoduck harvesting are very strict and tend to be last weeks to months longer than closures for other shellfish species. Information on the prevalence of PSP and closures can also be obtained at the WA DOH website listed above.

Finally, the local County Health Department will have information and a historical record regarding site specific contamination from local pollution sources (fecal coliforms from livestock, birds, seals, etc.) and should be considered prior to siting a geoduck farm.

#### *Sediment and Substrate Characteristics and Wave Exposure*

Beaches that accumulate sand in bars and flats from the erosion of coastal bluffs are often the best sites for geoduck culture as these areas tend to accumulate sands that are clean and free of significant quantities of gravel, wood or shell debris. The most successful geoduck farming is conducted on beaches with sand that is at least three feet deep. Often a layer of rocks, shells or hardpan will prevent geoducks from burrowing to a size/age specific depth resulting in stunting and reduced market quality. Probing the proposed site with a metal stake to investigate the potential depth of burial is a prescribed activity in site assessment for geoduck culture. Geoducks that are reared in areas of muddy or gravel substrates will often be discolored and lower in market quality.

Other sediment and substrate considerations involve the need to assess the rate of sediment deposition onto the proposed site. Storms may induce landslides and rapid erosion of nearby cliffs that result in rapid deposition of materials onto the geoduck farm making removal and extraction of clams more difficult. Long-shore drift of sediment and sand can be assessed by investigating drift cell deposition patterns that couple erosion of feeder bluffs to deposition of sediment. These have been identified for many sites in Puget Sound (see Puget Sound Action Team website: [http://www.psat.wa.gov/About\\_Sound/County.htm](http://www.psat.wa.gov/About_Sound/County.htm)) for information on drift cells in Puget Sound.

Exposure to storm waves is also important to consider. Winter storms typically produce large waves from a southerly or southeasterly direction in Puget Sound. Alternatively, air masses flowing out of the Frazier Valley in Canada can produce strong northerly winds during the winter. Long fetches and either south or north facing beaches being considered for geoduck culture may be significantly impacted by storm waves, especially at higher intertidal elevations. Some solutions to this problem involve using

longer geoduck tubes that are inserted to a greater depth into the beach. The norm has been to utilize 9" tubes on protected beaches and tubes up to 12" long for beaches that are subjected to greater wave action during winter storms. Also, planting at a deeper tidal elevation on this type of beach may result in greater success as tubes are exposed to waves less often and usually for a shorter duration of time.

#### *Tidal Height for Geoduck Culture and Weather Conditions for Planting Geoducks*

Intertidal geoduck farming has focused on planting (placement of seed into the tubes and covering/banding with mesh/rubber band) geoducks between the -2.0' and +2.0' tidal height (relative to MLLW) in many sites in Washington State. Most farms have focused on planting geoduck seed in the lower portion of this range, however the relative lack of good sites at this elevation has promoted increased experimentation at tidal heights up to the +2' elevation in the last several years. Planting geoducks at the higher intertidal elevations have also resulted in higher failure rates of seed, primarily due to the longer periods of time that seed are exposed to high summertime temperatures during low tide. Further experimentation is needed to discern the upper intertidal height limit for planting geoducks, but it is clear that even apparently successful plants (indicated by clams burrowing into the substrate following planting) may still be unsuccessful if on subsequent low tides the site is exposed to high summertime temperatures. There may be a size dependent threshold whereby clams are physically able to burrow to a depth where they are not subjected to heat stress. Experiments suggest that the larger the seed the better the planting success. Seed are normally planted at a size of 5-7mm shell length. Larger seed (9-13mm shell length) may be better suited for planting at high intertidal sites. Also, a good strategy is to plant seed in areas that will be covered in subsequent low tides on days immediately following the plant to allow the juvenile geoducks to acclimate to the site.

Local weather conditions are a critical component of geoduck farming. Planting geoduck seed during sunny weather when beach sediments and pooled seawater may warm to in excess of 22°C are to be avoided. Planting in cool, cloudy weather has proven to be far more successful. An alternative strategy is to plant geoduck seed just as the tide is covering the tubes. Allowing geoduck seed to lie on the sand dry is also to be avoided. A possible strategy is to place tubes into the substrate on one tide and return the following day(s) to add seed. Often, seawater is retained in the tube and allows seed to burrow into the sand soon after placement.

#### *Suspended Food Availability*

Site specific differences in growout are usually the case and locations with high suspended food availability and/or high current flow will result in higher rates of growth for cultured geoducks; areas with lower water exchange or lower productivity will usually result in reduced growth in geoducks. The fastest growth rates for geoducks are typically seen in southern Puget Sound where 1.5-1.75 lb geoducks may routinely be grown in 5 years. Sites in north Hood Canal (north of Dabob Bay) appear to require an extra year to reach this size, and sites planted on the north coast (Discovery Bay) may require more time as suspended food levels tend to be lower. This is a general observation, however and specific sites with high flow may in fact result in greater rates of production. Planting density also is a factor in determining growth rates as sites

planted at high density result in dramatically reduced size of geoducks. Research is being proposed by WDNR to determine the local carrying capacity of specific sites for geoduck culture, using planting density as a dependent factor in manipulative experiments.

### *Infrastructure Requirements for Geoduck Farming*

Geoduck farming requires a minimal amount of infrastructure due mainly to the relatively low maintenance requirements following planting. Infrastructure needs include a means for storing, cutting and transporting PVC to the grow out site. A barge or other water craft is usually preferred as large quantities of pipe sections need to be transported directly to the grow out site. This requires an efficient means for bulk transport and many growers now use 4" diameter pipe sections rather than the 6" diameter sections that were originally used. It is the general observation among some growers that 4" diameter pipe sections, while less expensive and easier to transport, do not enable as good a grow out environment for geoduck seed due to more restricted conditions and perhaps reduced water flow into the pipe section's micro environment. Moreover, 4" pipe sections tend to blow out of the substrate more easily than do 6" PVC sections during storm events. The added cost of 6" sections may not warrant their use, but these factors should be considered prior to initiating culture activities.

## **II Procurement and Deployment of Geoduck Culture Gear**

### *Preparation of PVC Tubes*

Procurement and deployment of geoduck culture gear consists primarily of purchasing and cutting either 4" or 6" PVC thin wall sewer pipe sections to a length of slightly greater than 9". This enables 13 sections to be cut from a single 10' pipe section. Pipe sections that are 4" in diameter may be cut quickly and reliably on a standard "chop" saw, while cutting 6" diameter drain pipe usually requires the use of a 12" band saw. Drain pipe may be purchased in bulk in "slings" that contain 900' of pipe. The accompanying Excel spreadsheet details these costs, but recent increases in petroleum costs have induced an increase in price for most plastic pipe; 4" sections are approximately 50% the cost of 6" sections, but 6" sections have more than twice the area (28.26 square inches compared to 12.56 square inches).

Pipe sections are cut and moved to the selected intertidal site with transport often economized by loading pipe section into fabric bulk carriers used in many agricultural industries for holding and transporting produce. Once on site, tubes are placed into the sand to a depth of about 6 inches, leaving about 3 inches of pipe exposed. Pipe sections are generally spaced at 12-18" intervals in rows. Establishing a regular pattern of pipe sections using tape measures is usually advantageous and provides the room for optimal grow out density of clams and provides a visual frame of reference for harvesting.

Placing the tubes into the intertidal substrate is a labor-intensive activity. Deployment requires the practice of tube "stomping", where tubes are inserted by working them into the substrate by foot. A deployment of 2000 tubes per 4-6 hour low tide period may be anticipated by a well-organized crew of six if the tubes are clean and on site at the start of the low tide period. Hydraulic tube planters have also been deployed and may replace the need for extra workers during tube deployment. These operate by

using a spray of seawater supplied by a gasoline pump and hose to ease insertion into the substrate. There are at least two designs of planting devices; both utilize pressurized seawater expelled in a circular pattern the same diameter as the PVC pipes.



*Geoduck tubes inserted into the substrate with geoduck seed (without mesh tops)*

### *Geoduck Seed Preparation and Planting*

When tubes are ready for planting seed, juvenile geoducks should be transported to the site in coolers with refrigeration if the transit time is greater than a couple of hours. Costs for geoduck seed are regulated by supply, size of the seed and season. Recent increases in seed price reflects a relative lack of supply, however current prices (\$0.20-\$0.45/each) remain well within the range of 3%-5% of the harvested wholesale price of geoduck when compared to other cultured shellfish. In any case, the initial cost of the seed is high and the juvenile geoducks must be carefully cared for. The seed should remain at the temperature of the nursery system they originated from, and should in any case not exceed 15 °C. The hatcheries producing seed will generally pack the clams for shipment of a duration of 3-4 hours, and growers should be prepared to handle seed within this transport window.

Geoduck farmers often transport seed out to their farms well before planting in order to acclimate the seed to the precise growing conditions the geoducks will encounter. This practice also allows seed to grow a bit prior to planting which generally improves survivorship. Various nursery systems are in use, but the preferred method is to place plastic “kiddie” pools onto the intertidal, fill the pools with clean sand to a depth of about one third to one half the volume of the pool, add juvenile geoducks and cover the pools with mesh so that crabs and other predators can not gain access. Seed may remain in the nursery pools for weeks or months if not overcrowded. A typical stocking density for kiddie pools depends on the size of the seed, and has ranged between 1500 6-8mm seed and up to 3000 3mm seed per pool in typical applications.

Planting geoducks into the PVC tubes is the next activity. Again, attention to the weather conditions for optimal planting success is critical, and should not be attempted unless the planting is done very close to the end of a tide or preferably under cloudy conditions. Each PVC pipe section typically receives 2-3 geoduck seed (5-10mm in shell length). Seed is usually planted by hand. Over each tube is stretched a mesh net secured



in place by a rubber band. Netting for covering tubes is available at Norplex, Inc. (253-735-3431). Rubber bands (Number 84) are also available locally at most office supply outlets.

A block of planted tubes might consist of approximately 0.5-acre area containing 100 rows of 200 tubes per row of planted geoduck. Each year-class of blocks consisting of 20,000 tubes contains between 40 thousand to 60 thousand geoduck seed. Optimal planting time is the spring and early summer months (May – July) during low tide series, although excellent success has been obtained planting later in the summer during early morning low tides when air temperatures may be lower.



*Planting geoduck seed by Joth Davis at Thorndyke Bay (Baywater, Inc.)*

## *2. Year-to-Year Maintenance of Tubes:*

### *Year 1*

Tubes are maintained for the first year with the mesh nets in place, or if fouled these may be replaced. This practice ensures the greatest possible protection for the geoducks as they are vulnerable to ducks, flatfish and crabs. Some sites appear to have significantly greater predation pressure than others, and some farms have found they can remove tubes after the first six months to one year with minimal impacts to the geoducks. Other sites require up to three years prior to tube removal. Fouling animals and green seaweeds (*Ulva* sp. and *Enteromorpha* sp.) are removed at regular intervals. If cockles (*Clinocardium nuttallii*) colonize tubes, these are removed to reduce competition for the year-old geoducks.

*Year 2*

Maintain blocks of tubes as above. Maintenance also includes regular monitoring to ensure that tubes are not blown out of the beach during winter storms. Regular sweeps to recover washed out tubes must be adhered to on a routine basis.

*Year 3*

Geoducks should be large enough to avoid being eaten by diving sea ducks (mainly scoters), crabs and flat fish at most sites. As noted above, a three-year deployment of tubes prior to rotation is the most conservative husbandry practice currently in use today, and many sites may not require this measure of protection. Because the availability of tubes constitutes a significant portion of the annual budget, tube rotation practices must be established, and may only be estimated prior to conducting pilot studies. In any case, tubes that are removed are now available for cleaning (knocking off barnacles and other fouling organisms) prior to using for another block of planting.

*Year 4-5-6*

Little maintenance other than that described above until harvest is initiated



*Hatchery produced geoduck seed*

**Harvesting Practices**

The harvest operation requires a gasoline powered water pump and hand-held water jet (“stinger”) supplied by 75-150’ of flexible 2” diameter discharge hose. Clams are extracted by inserting end of the 18” stinger adjacent to the geoduck siphon and fluidizing the sediment to a depth that the clam can be easily removed. Harvesters typically create a waist-deep depression in the substrate and operate by slowly moving up-slope extracting clams. (see photo below). This practice allows water from the stinger to exit behind the operator and flow away down-slope. Extraction rates vary greatly depending on the density of geoducks and skill of the harvester, but removal of 4-6 geoducks per minute appears to be an average harvesting rate by seasoned operators over a four hour tide.



### Harvest Potential from 20,000 Tube Blocks

Survival rates for geoduck growing to a harvestable size of 1.5 lb are highly variable and depend on a host of factors relating mainly to early seed survival and site. For the sake of this discussion, a successful annual harvest from 20,000 tubes might constitute 20,000 grade #1 geoducks if mean survival was equal to one geoduck per tube. Assuming that clams are grown long enough and at a density to support an average weight of 1.5 lbs, then 30,000 lbs. may be harvested annually from each block of 20,000 tubes. At a current market rate of \$8.00 per pound for grade #1 geoducks, this harvest level represents gross revenues of \$240,000 per block of tubes. Higher geoduck survivorship, harvesting at a larger size and marketing clams when prices are higher would have a significant and positive effect on revenues. Obviously, returns can be significantly lower if predators or environmental conditions suppressed survivorship during the growout phase of the operation. As stressed above, the biomass of geoduck available at harvest will be highly variable based on many factors, most of which are related to site specific criteria, the quality of the seed used for the initial plant and survivorship of seed during the first year of growout.



*Harvesting geoduck on intertidal farm in Puget Sound, WA*

### III Risk Factors Associated with Geoduck Farming and Leasing Guidelines

The following section summarizes the known risks associated with geoduck farming. Most of these factors have been mentioned above, however it is critical to understand the myriad of conditions that may affect the ability to farm geoducks on tidelands in Washington State.

1. Selection of the proper substrate for planting to produce #1 grade geoducks is critical. Muddy or other types of substrates produce #2 and lower grade

- geoducks, which are not as valuable. This type of substrate is at a premium in Washington State.
2. Overcrowding or sub-optimal growth rates will lengthen the time to harvest. Care must be taken to maintain the proper planting density of clams to preclude overcrowding. It appears that at least five years are required to grow clams to the 1.5 lb size in southern Puget Sound and a year longer in northern Puget Sound and Hood Canal.
  3. Losses of seed due to heat stress and predation of young clams are the major risk factors during the first year following planting.
  4. Planting conditions during the spring and summer are critical. The ideal planting day is cool with cloud cover and no wind. The initial hours after planting are critical, as the young clam seed must burrow into the sediment in order to survive. Hot, windy days are not suitable for planting. Also, fouling by green seaweeds and low salinity conditions can significantly affect the survivorship of seed in the first hours or days after planting.
  5. Poaching could become a significant factor once it is recognized that geoducks are being farmed in a new location. Security issues are important to consider.
  6. Supply of farmed geoduck is expected to increase over the next few years, and may depress dockside prices for fresh geoduck as the industry matures. To counter this outcome, however is the similar likelihood that knowledge of increased availability of geoduck may stimulate greater market demand, offsetting possible declines in price due to increased supplies.
  7. Development of geoduck culture in China is a concern with little information available regarding the current state of development there or in Asia generally. Large-scale geoduck production in China would likely have negative effects on export potential of US farmed product. Current indications of geoduck produced in China suggest that it is of lower quality currently.

### **Guidelines for Leasing Privately Owned Tidelands in Washington State**

1. Annual lease payments are usually proposed at a rate of \$1000 per acre annually and may be prorated annually to the acreage under cultivation or otherwise used for the operation.
2. Once geoduck harvests are initiated after the 5<sup>th</sup> or 6<sup>th</sup> year, the landowner typically shares in an additional 7%-10% of gross receipts based on the harvest and sale price of geoduck. The value used for this calculation is usually the average for the price received for geoduck the previous 12 months, or fraction of this period (during the first year of harvest).
3. The term of leases is highly variable, and ranges between the length of time necessary to grow and harvest a crop of geoducks to any longer time frame negotiated.
4. Performance clauses are standard and are usually developed and written to ensure that the lessee will achieve maximal sustained geoduck production over the prescribed time frame.

#### **IV Expense and Income Projections**

The accompanying spreadsheet provides for a description of a proposed operation for a new farm that is installing 20,000 tubes annually over a period of years with the harvest of geoducks occurring after the fifth year.